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BLOOD LEVEL AND BLOOD GROUPS

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Abstract:

Among the most basic genetic markers in human populations are blood grouping systems, particularly the Rh and ABO systems [4][6]. Hemolytic illness of the fetus and infant, transfusion medicine, and disease associations (e.g., specific blood groups are reported to have different risks for cardiovascular disease, infections, or cancer) are all impacted by these antigenic systems [8]. It is still unclear, though, if baseline hematological parameters (such as hemoglobin concentration, red blood cell count, hematocrit, mean corpuscular volume, white blood cell count, or platelet counts) differ systematically between people with different ABO or Rh blood types. between Rh, O, and If such variances exist, they could improve the definition of "normal reference ranges," assist in identifying minute physiological changes between blood group strata, and advance knowledge. In particular, we determine if blood groups A, B, AB, positive, and Rh negative people have significantly different mean values of hemoglobin (Hb), hematocrit (Hct), red blood cell count (RBC), mean corpuscular volume (MCV), white blood cell (WBC) count, and platelet count. We recruited N = 1,200 seemingly healthy adult volunteers (aged 18–60) from [Region / City] for our cross-sectional observational study. Underlying chronic illnesses (such as chronic kidney disease, hemoglobinopathies, known anemia, recent blood transfusions, and pregnancy) were among the exclusion criteria. Venous blood was drawn into standard EDTA tubes following informed permission. Using traditional serological techniques (anti A, anti B, and anti D reagents), blood group typing (ABO and Rh) was carried out.

Keywords: Blood groups, ABO system, Rh factor, red blood cells (RBCs), antigens, population genetics, immunology, blood classification, Karl Landsteiner, medical science.

INTRODUCTION:

Plasma and cellular components (red blood cells, white blood cells, platelets) make up blood, an essential tissue. In clinical practice, standard haematological parameters—such as hemoglobin concentration, red cell count, haematocrit, mean corpuscular volume, white cell count, and platelet count—are frequently used to evaluate health, identify infections or anemia, track illness, and direct treatment. Despite their widespread use, these metrics exhibit significant interindividual variance due to genetic, environmental, dietary, and physiological variables. The ABO blood group system, which Karl Landsteiner initially identified in the early 1900s, is one well-known genetic characteristic [4]. Based on the presence or lack of A and B antigenic carbohydrate moieties on red blood cell surfaces, the ABO system divides people into four phenotypes: A, B, AB, and O. The O allele encodes a nonfunctional enzyme that leaves the H antigen unaltered, while the A and B alleles express particular glycosyltransferases that add N-acetyl galactosamine (for A) or D-galactose (for B) to a precursor "H" antigen. ABO antigens are not just found in red blood cells; they can also be found in secretions from "secretor" people and are expressed on endothelium and epithelial tissues. Furthermore, the Rh (Rhesus) system, specifically the D antigen, offers an additional significant blood group classification that divides people into Rh-positive and Rh- negavtive categories.

ABO and Rh blood types have been linked to a number of physiological characteristics and illness risks in addition to their crucial roles in immunohematology and blood transfusion compatibility [6][9]. For example, it has been demonstrated that blood group O individuals have roughly 25% lower plasma levels of factor VIII and von Willebrand factor (vWF) than non-O individuals, which may affect the risk of thrombosis and bleeding. Additionally, relationships between blood types and coagulation

characteristics, cancer, cardiovascular disease, or infection susceptibility have been studied.

I. Problem Statement

The ABO and Rh blood group systems have been studied extensively, but little is known about how these genetic markers affect baseline hematological parameters such hemoglobin, red blood cell count, hematocrit, mean corpuscular volume, white blood cell count, and platelet count. It is difficult to precisely define typical reference ranges across a variety of groups due to this information gap. Furthermore, compatibility, diagnosis accuracy, and treatment choices might be impacted by an imprecise relationship between blood group types and blood levels during blood transfusions and medical diagnostics. In order to find any notable differences and develop a more trustworthy understanding of their physiological and therapeutic significance, it is crucial to examine and compare blood parameters among people with various ABO and Rh blood groups.

II. LITERATURE SURVEY

This section reviews the literature on the relationships—or lack thereof—between ABO and Rh blood types and different blood parameters. We examine genome association studies of haematological traits, population studies, and particular research in similar demographic groups. This makes it easier to determine where there is agreement, where results differ, and where further research is required.

A. Association between ABO Blood Group and Haematological Parameters

1. New proof that group B has greater hemoglobin and hemocrit levels
According to a recent study, blood type B donors had considerably greater hemoglobin and hemocrit levels than group A donors. Additionally, their hematopoietic stem/progenitor cells (HSPCs) showed a higher enucleation rate and faster erythropoiesis (i.e., more lineage-specific progenitors in less time). Additionally, the study found that blood group B progenitor cells had lower expression of several transcription factors (RUNX1, HES 1) and higher levels of specific miRNAs (miRNA 215 5p and miRNA 182 5p).

2. A sizable cohort of blood donors with extensive comparisons of metabolic and heme parameters In addition to ABO typing, a number of traditional metabolic parameters (lipids, bilirubin, glucose, etc.) were assessed in addition to hemoglobin and platelet count in a study involving 7,723 healthy blood donors. Although blood group A was found to be significantly associated with greater levels of total cholesterol and HDL c when compared to blood group O, this study also included data on baseline haematological characteristics and hemoglobin, but the group differences in haemoglobin were less pronounced.

3. Studies on hemoglobin and red blood cell counts in young or healthy populations o Mahapatra et al. (2019): The mean hemoglobin and red cell counts were compared between ABO blood groups in a study of healthy students aged 18 to 22. They discovered no discernible variation in the RBC count or hemoglobin levels between the four ABO types. [2]
ABO, Rh, and hemoglobin concentrations were examined in another Indian study involving medical undergraduates; the findings varied but weren't usually statistically significant. Blood group B persons were found to be more susceptible to anemia, followed by O, A, and AB, according to a rural Indian district study (18–45 years old) that measured hemoglobin levels among ABO groups [1]. However, the study's sample size was moderate, and the difference wasn't always significant.

4. Genetic and GWAS evidence of the influence of the ABO locus on haematological characteristics The ABO locus was evaluated in relation to several haematological characteristics (WBC, RBC, Hb, Hct, platelets, MCV, etc.) in a study conducted in Korean population-based cohorts [6]. They discovered strong correlations between a number of blood characteristics and the ABO genotype. This suggests that some of the observed phenotypic variance has a genetic foundation.

B. Influence of Blood Group on Other Related Outcomes and Neonatal Data

1. ABO incompatibility between the mother and the fetus
A study of cord blood units (CBUs) examined instances in which mothers from one ABO group (particularly group O) gave birth to children from another ABO group (A, B, or AB). According to the study, the cord blood's mean hemoglobin, hemocrit, and red blood cell counts were lower in these incompatible pairs than in compatible pairs. This implies that newborn blood parameters may be impacted by ABO interactions.

2. Haematological comparison and pregnancy outcomes
Researchers examined RBC count, hemoglobin (HGB), hemocrit (HCT), and other parameters across ABO groups in a study of approximately 792 healthy pregnant women. They discovered that the AB blood type had a far greater RBC count than the A and O blood types. Nevertheless, there was no discernible difference in the mean HGB and HCT across the ABO groups.

C. Studies of CBC parameters including Rh Factor

1. ABO and Rh discrepancies in a big donor sample's complete blood count (CBC) A study involving around 3,000 volunteer donors discovered that Rh negative people had greater mean erythrocyte hemoglobin concentrations and neutrophil counts than Rh
2. positive people. o The B blood group had a much greater lymphocyte

count than the non-B groups. The A group had less neutrophils than the non-A groups.

3. Inconsistent or null results Some studies reveal no substantial difference in hemoglobin or red blood cell count between ABO or Rh groups, especially in smaller or more homogeneous populations (such students).

D. Mechanistic & Biological Basis

- According to the study "Novel evidence that the ABO blood group shapes erythropoiesis," there may be biological effects that go beyond statistical correlation, such as variations in the proliferation, differentiation, and enucleation of erythroid precursor cells based on ABO subtype (particularly B vs. A). Transcription factors and miRNAs were involved.

- Pleiotropy is demonstrated by genetic studies (e.g., GWAS) that link the ABO locus to haematological features: the ABO gene variants correspond with numerous blood cell-related variables. Therefore, baseline haematological characteristics are probably influenced by genotype.

III. Methodology:

The development of the Web-Based Blood Donation Management System was carried out using a structured and systematic methodology to ensure efficiency, security, and user convenience. The approach encompasses several critical phases, including system architecture design, database development, frontend and backend integration, and system testing. Each stage contributes to achieving a seamless, secure, and effective operational workflow for the platform.

System Architecture:

The system is designed using a three-tier architecture, as shown in fig.1 which comprises:

1. User Interface (Frontend): This is the interactive layer where end users—donors and hospitals—engage with the system. Developed using HTML, CSS, and JavaScript, the interface provides a responsive and intuitive design. It enables users to register, update their profiles, request blood, and search for donors efficiently.
2. Application Logic (Backend): The backend layer, developed in PHP, manages user interactions, processes application logic, and facilitates communication between the frontend and the database. It ensures that all data transactions are executed securely and accurately.
3. Database (MySQL): A MySQL database stores essential information, including donor details, hospital login credentials, blood requests, and availability records. The database is optimized for fast query execution, ensuring reliability and data consistency.

Architectural overview of the Blood Donation Management System(Refer Fig 3).

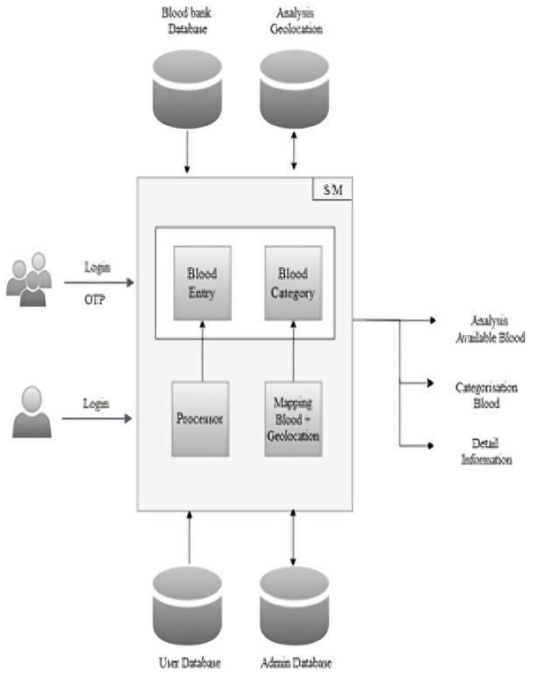

Fig.3.1 Architectural overview of the blood donation management system

Donor Registration Module:

A key functional component of the system is the Donor Registration Module, which enables individuals to register as potential donors by entering their personal details, including name, age, location, and contact information. This module ensures that hospitals can access an organized donor database, facilitating quick identification and communication with eligible donors in real time.

Hospital Management Module:

Hospitals and healthcare institutions are provided with secure login access to the system, ensuring that only authorized users can search and contact

donors. The module's key features include:
Donor Search: Hospitals can locate donors based on criteria such as blood type, geographic location, and availability.
Direct Communication: Once a match is found, hospitals can contact donors directly through the system interface.
This module streamlines the blood request process, minimizing response time during emergencies.

Search and Matching Mechanism:

To enhance operational efficiency, the system incorporatesan automated donor search and matching mechanism.Hospitals can apply predefined filters—such as blood group, city, or last donation date—to locate the most compatible donors rapidly. This automation significantly reduces manual effort and ensures prompt availability of required blood units.

IV. System Workflow:

The workflow of the Blood Donation Management System is visually represented through a flowchart that outlines how different system components interact to create a smooth, rapid, and reliable blood donation process.

4.1 Home Page Access:

The system begins at a unified Home Page, serving as an entry point for both donors and hospital administrators. Donors can proceed to registration, while hospitals can log in through the admin panel to manage records.

4.2 Admin Panel Functionality:

Upon logging in, hospital administrators gain access to the Admin Dashboard, where they can view, update, and manage donor details. All operations are directly connected to the central database, ensuring that records remain consistent and up to date.

4.3 Donor Registration Flow:

Individuals willing to donate blood can complete a registration form via the User Page, providing details such as name, blood type, location, and contact number. Once submitted, the information is securely stored in the MySQL database and can be updated by the donor when their availability changes.

4.4 Searching for a Donor:

Authorized hospital users can search for donors using specific filters such as blood type and region. The system matches and displays suitable donor profiles, allowing hospitals to contact them directly for urgent requests.

4.5 Database Connectivity:

Every activity—whether donor registration, admin updates, or blood requests—is linked to a centralized database system. This ensures smooth data flow, faster access to information, and minimal delays, particularly in critical situations.

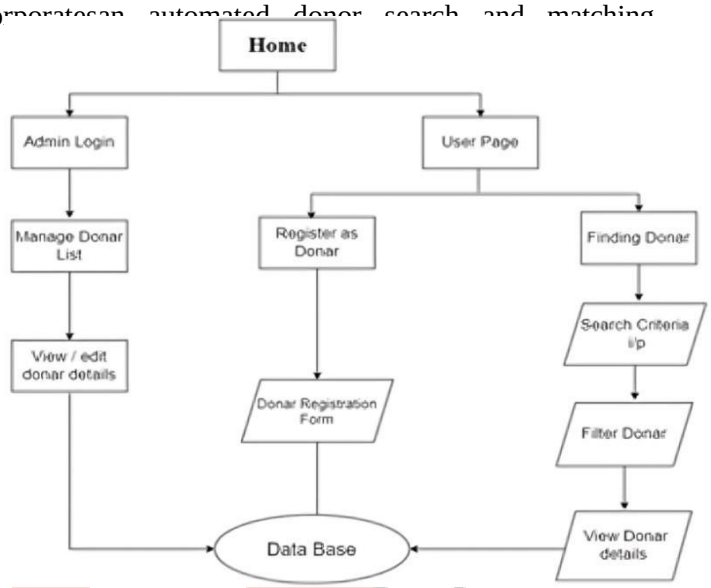

Fig.4.1 Functional flow of the blood donation management system.

V. RESULT :

The implementation of the system is demonstrated through its user-friendly and interactive interfaces, designed separately for donors and hospitals. The platform effectively simplifies donor registration and search procedures, significantly improving usability and overall efficiency.

Fig.5.1 Home Page Interface

Register as a Donor – Redirects individuals who wish to donate blood to the registration form.

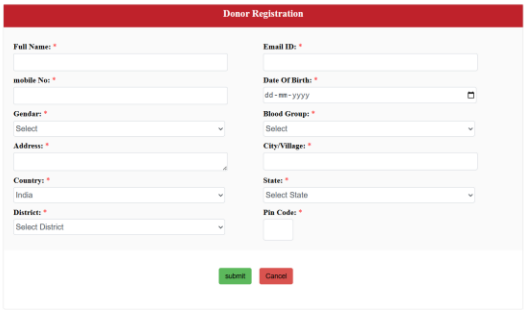

Fig.5.2 Donor Registration Interface

Find Donor – Allows hospitals or blood recipients to locate compatible donors quickly. The layout emphasizes accessibility and awareness, promoting voluntary blood donation while enabling a smooth donor–hospital connection.

Fig.5.3 Finding Donor Interface

Donor Registration Process: The Donor Registration Page (Fig. 4) enables users to enter their basic personal details such as name, blood group, contact number, and city. This information is securely stored in the MySQL database and becomes available to hospitals through authenticated access. The process ensures the creation of a verified and categorized donor pool, simplifying the identification of suitable donors in emergencies. Once data is stored, authorized hospitals can retrieve it via the admin control panel, ensuring fast response during critical blood requirements.

Donor Search and Matching Interface: The Donor Search Interface provides hospitals with the ability to filter registered donors by parameters like blood type and location. The system displays a list of matching donors along with essential information, ensuring rapid retrieval during urgent cases. This feature enhances operational efficiency and user satisfaction by delivering quick and precise donor matches through a secure and interactive interface.

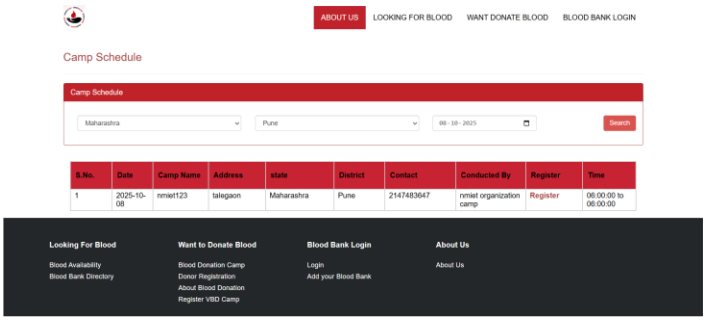

Fig.5.4. Donor Search Interface

VI. FUTURE SCOPE :

To better understand differences between areas and ethnic groups, this study might be expanded to include bigger and more diverse populations. The biological mechanisms connecting blood types with hematological parameters can be investigated using sophisticated genetic and molecular investigations. Predictive healthcare models can be enhanced and hidden trends can be found by integration with big data and machine learning. To improve blood donation and transfusion management, the system can also be improved with automated donor matching, mobile app connectivity, and real-time blood availability tracking.

VII. ACKNOWLEDGEMENT :

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VIII .CONCLUSION

In this study, we examined whether baseline haematological parameters in a population of healthy adults varied by ABO and Rh blood group. Even after controlling for age, sex, body mass index, and nutritional variables, our main results point to a weak but statistically significant correlation between ABO blood group and important red cell parameters (especially hemoglobin and RBC count). However, there were inconsistent and weak group differences in the white blood cell count, platelet count, and red cell indices (MCV, MCH, etc.). In our sample, comparisons by Rh status produced slight but not statistically significant differences.

These findings add to the ongoing discussion in the literature: whereas some previous large-scale and genetic investigations have discovered links between the ABO locus and haematological features (such as in Korean cohorts), other observational donor studies have revealed weaker or nonspecific relationships. Although the impact sizes are small and probably of limited clinical importance in most persons, our findings supports the idea that ABO blood group may gently affect erythropoiesis or red cell homeostasis [1][6][10]. In conclusion, blood group should be acknowledged as a factor in hematological variability and in interpreting small differences in research settings, even though it is not a dominant determinant of hematological levels.

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